B. SYNOPSIS OF FEDERAL AND INDUSTRY STUDIES OF ENERGY R&D REQUIREMENTS AND RECOMMENDATIONS

Chapter 1 of this Joint DOE-EPRI R&D Plan refers to several studies conducted over the past three years by DOE and the nuclear industry which evaluated the nation's projected energy needs and supplies for the future. Each of them made recommendations or developed plans for ensuring energy security for the next century; all contain a strong nuclear energy component. These studies were reviewed and the salient points of each, as applicable to the nuclear energy R&D needs, were integrated to form the basis for this Plan.

This Appendix provides a synopsis of each of the documents referenced in Chapter 1, with emphasis on recommendations regarding nuclear energy R&D and potential impact on the future energy supply of the nation.

B.1 1997 PCAST Energy Study

In Jan. 1997, in response to a recommendation from PCAST, President Clinton asked his Science Advisor to work with the Secretary of Energy "... to review the current energy R&D portfolio, ... to make recommendations, ... to ensure that the U.S. has a program that addressees its energy and environmental needs for the next century." The PCAST energy study, chaired by John Holdren (Harvard University), made its recommendations to the White House in November 1997.

Pertinent excerpts from the PCAST Report related to nuclear energy R&D:

"*DOE's R&D in nuclear fission energy systems, which fell 12-fold in real terms between 1986 and 1997, would increase under our proposal from about $40M per year in FY97 to about $120M per year in 2003 (as spent dollars), thereby returning in real level of effort to that of 1995. Nuclear fission currently generates about 17% of the world's electricity; if this electricity were generated instead by coal, world carbon dioxide emissions from fossil-fuel consumption would be almost 10% larger than they currently are.*"

"*We believe that the potential benefits of an expanded contribution from fission in helping address the carbon-dioxide challenge warrant the modest research initiative proposed here, in order to find out whether and how improved technology could alleviate the concerns that cloud this energy option's future. To write off fission now as some have suggested, instead of trying to fix it where it is impaired, would be imprudent in energy terms and would risk losing much U.S. influence over the safety and proliferation resistance of nuclear energy activities in other countries. Fission belongs in the R&D portfolio.*"

Overall, PCAST recommended expanding the energy R&D budget from $1.3 billion per year to $2.4 billion per year by 2003, with annual increases of:

$500 million in end-use-energy efficiency (to $880 million in 2003),
$400 million in renewables (to $652 million in 2003)
$100 million in fusion (to $328 million in 2003)

$80 million in fission (to $119 million in 2003)
$70 million in fossil (to $433 million in 2003)

B.2 DOE Strategic Plan

DOE issued its second Strategic Plan in September 1997 under Secretary of Energy Federico Peña. This plan continued many of the themes of the first Strategic Plan issued under Secretary O'Leary, but added more specific strategies and metrics to assist in DOE's implementation of its mission and vision. Also included in this second Strategic Plan was a more explicit recognition of the importance of nuclear energy in achieving the nation's energy and environmental goals. Several objectives and implementing strategies specifically addressed nuclear energy, demonstrating the Department's commitment to keep a viable nuclear energy option. Those specific objectives are listed in Appendix C.

B.3 EPRI Nuclear Energy R&D Strategic Plan in Support of National Nuclear Energy Needs

EPRI was requested by the Advanced Reactor Corporation to prepare a national nuclear energy R&D strategic plan that addresses, from a utility and electricity consumer perspective, the nation's nuclear energy R&D needs. That Nuclear Energy Strategic Plan was first issued in July 1996 and endorsed by various utility industry Boards and Committees in August 1996. The Plan was updated and re-submitted to DOE in June 1997.

The request to EPRI came at a time when several factors made, and are still making, nuclear energy R&D planning more urgent, such as the dramatic reduction in federal R&D investment in the nuclear energy supply sector; and the complex institutional factors governing nuclear power. Deregulation was also forcing utilities to look harder at every R&D dollar they invest – to make sure that priorities are aligned to current and near-term needs. As with federal investments in R&D, utility investments in longer term R&D are being scrutinized against realistic projections of energy requirements.

The utilities saw an urgent need for a long term strategic plan that looked at U.S. nuclear energy needs from a global perspective, in a way that better defined the roles of the private and public sectors. Consultation with DOE, review by utilities, and coordination with the proper industry and government bodies were all essential steps in developing the plan. Importantly, utilities asked that the strategic plan be meaningful and realistic – in terms of level of investment and pace of R&D, and in terms of meeting energy supply scenarios that make sense, both in the U.S. and in the global markets.

Industry proposed that the proper level of Federal Government investment in nuclear energy supply R&D for FY98 should be $70 million. This $70 million was viewed as an appropriate level to meet minimum requirements for planned work in LWR research. It was only 5% of DOE's overall energy R&D budget, and was justified on the basis of funding rationales that were used for other energy R&D programs at DOE. A small portion of this funding was for completion of cost shared work under multi-year agreements between DOE and industry (e.g., closeout of current ALWR programs). A much larger portion is related to research in support of

technologies that will enable a cost-effective license renewal process to extend the operating lives of current nuclear plants. These technologies are applicable to both current and future nuclear plants in the U.S., and have high market value overseas as well.

The goals and objectives from the EPRI Nuclear Energy R&D Strategic Plan applicable to this Joint Strategic Plan are listed in Appendix C.

B.4 Nuclear Energy Security, A DOE Initiative to Help Maintain a Diverse U.S. Electricity Supply

DOE proposed a new initiative in 1997 that focused on R&D of new technologies critically needed to help assure the economic operation of existing nuclear power plants through their current and renewed license terms, while at the same time enhancing safety and minimizing the generation of spent nuclear fuel. This effort was intended to help maintain the current share of nuclear generation and preserve the option to increase its use in the future.

Congress chose not to fund this program in FY 1998, but instructed DOE to propose a strong and well-supported proposal for nuclear energy R&D for funding in FY 1999. This new Joint Strategic Plan has been prepared in response to that request.

B.5 DOE Laboratory Directors Report on Technology Opportunities to Reduce U.S. Greenhouse Gas Emissions

Eleven national laboratory directors were tasked by Secretary Peña to provide input on possible technology pathways to help reduce greenhouse gas emissions. Their report described nearly 50 technology pathways that address three areas: energy efficiency, clean energy, and carbon sequestration. The technology pathways comprise the basis for the formulation of a national climate change technology strategy, based on government partnerships with industries and universities. One of the clean energy recommendations of the laboratory directors is to change the energy mix to increase the use of sources with higher generating efficiencies and lower emissions. Safer and more efficient nuclear power plants was listed among the possible technology pathways.

B.6 DOE Laboratory Directors Recommendations for a DOE Nuclear Energy R&D Agenda

Seven national laboratory directors were asked by Dr. Terry Lash, Director of DOE's Office of Nuclear Energy, Science and Technology in 1997, to assist in the formulation of a government sponsored nuclear energy R&D agenda for the future. Their recommendations were developed as the PCAST was conducting its energy R&D evaluation and submitted to Secretary Peña in December 1997. Their recommendations were similar to those of PCAST, with the intent of complementing PCAST recommendations to help ensure the health of the U.S. nuclear energy industry and expertise base, as well as to enhance the credibility and leadership role of the U.S. in the international nuclear energy arena. The laboratory directors recommended five approaches to and areas of nuclear energy R&D to ensure the U.S. government continues to wield global influence on important nuclear energy issues, maintains its nuclear technical

competencies, and provides important energy options for the nation's and the world's future energy needs.

1) Nuclear Energy Research Program. Create a comprehensive research program for nuclear energy, science, and technology to revitalize nuclear energy research at major universities and DOE laboratories. This initiative should be designed to ensure and strengthen the coupling between the creative resources of the universities and the programmatic focus of the laboratories. Programs and topics might include basic nuclear science and engineering as well as a wide range of applied topics such as fuels and materials, novel reactor and systems designs.

2) Nuclear Energy R&D to Meet U.S. Carbon Emissions Reduction Goals. Pursuit of technologies for both Life Extension and Generation Optimization (LEGO) and next-generation nuclear power would continue current nuclear greenhouse gas emission reductions, and enable additional reductions in the future. R&D into monitoring, diagnostics, computing, and materials technologies is needed to help the United States avoid the premature closure and decommissioning of its operating nuclear reactor fleet. Successful development and use of more efficient and cost-effective nuclear power technologies that address the goals of safety, efficient resource utilization, and waste management could also have a major impact on global carbon emissions.

3) Enhanced Proliferation Resistance. Because of the projected spread and increase of nuclear energy internationally and future uncertainties associated with world events, it is prudent for the United States to reinvigorate efforts to explore more proliferation-resistant forms of nuclear energy. A broad effort including systems studies to identify more advanced proliferation resistant technologies is needed.

4) High-Efficiency Nuclear Fuel. Cooperative development with industry of improved fuels with extended burnup, demonstrated safety margins, and capacity to enable longer operating cycles may reduce the government's costs for spent fuel disposition and improve nuclear plant operating efficiencies.

5) International Nuclear Cooperation. Cooperation will allow the U.S. to continue its strategy of technology and safety improvements, influencing world-wide nuclear development, and initiating international research. Nuclear safety and nuclear nonproliferation have been and are two key elements of U.S. international nuclear policy, and global collaboration is a necessity in order to preserve U.S. influence within the international nuclear community.

B.7 Secretary of Energy Advisory Board Report of the Task Force on Strategic Energy R&D

The Secretary of Energy Advisory Board (SEAB) Report of the Task Force on Strategic Energy Research and Development (R&D)[12] discussed the critical importance of energy supply, and

[12] Energy R&D: Shaping Our Nation's Future in a Competitive World; report of the Task Force on Strategic Energy R&D (Yergin Report), June 1995

noted the widespread cutbacks in energy R&D investments by both the public and private sectors, at a time when science and technology are of growing importance for meeting national needs and global challenges in both energy and the environment. It focused significantly on the R&D process, and has been used extensively to shape the views in this Joint Strategic Plan regarding the respective roles of government and industry.

The SEAB Report (often called the "Yergin Report") found a brewing crisis in energy R&D, a lack of criteria and rationale for prioritizing energy R&D, and a resulting shortfall in achieving a balanced, goal-based energy R&D portfolio. It proposed strategic goals to serve as criteria for measuring energy R&D priorities, and advocated cost sharing with industry to leverage funds, to accelerate the R&D process, and to transfer results into the economy and the marketplace.

The Yergin Report strongly advocated a market-driven approach to energy R&D at DOE, benchmarked against private sector management practices. Regarding the content, prioritization, and conduct of energy R&D, the following recommendations from the Yergin Report presented a clear vision and success path for defining the public and private sector roles in energy R&D.

"The Task Force recommends that DOE develop an integrated strategic plan and process for energy R&D, and use this process to determine funding priorities and manage a diverse energy R&D investment portfolio, through:

> *A balance of basic research and applied R&D (including industry co-funded demonstrations).*
>
> *Near- and long-term R&D to provide continued return on investment and to contribute to the health and vitality of domestic energy industries.*
>
> *A continuing commitment to support energy efficiency and renewable energy.*

The Federal Government's energy R&D investment portfolio should be aimed at and measured against the following criteria:

> *Energy-related R&D investments should serve to promote strategic goals, including U.S. economic strength, energy security, environmental quality, and science and technology leadership.*
>
> *Federal R&D programs should be based and prioritized on the systematic application of measurable cost-benefit criteria tied to strategic economic or national goals.*
>
> *DOE should evaluate the more widespread use of peer-reviewed competitions as a basis for awarding support in its more applied strategic energy R&D programs*
>
> *Shared co-funding with industry should be the norm for near- to medium-term energy R&D programs, in order to leverage dollars."*

The Task Force expanded on the above recommendations with more detailed insights and guidance that contribute directly to answering the federal role issue:

> *"At a time when reducing the federal deficit is a necessity, the fact that industry is cutting back energy R&D does not itself justify federal spending on R&D. However, industry is reluctant to invest in research that is too long-term, too risky, too early, too far from the immediate objectives of the business unit, or too capital-intensive for pre-commercial investment by a single company. But industry is willing to leverage the investment made by the Federal Government with private funding. For energy technology demonstration projects, at least half of the funding should be expected to be provided from industry partners as a strong indication of their interest in the eventual commercial success of the venture.*
>
> *The Task Force recognizes the concern expressed by some that cost-sharing may constitute a form of "corporate welfare." However, we observe that cost-sharing was introduced by the Reagan and Bush Administrations in the 1980s to spur R&D productivity, and to achieve three objectives:*
>
> > *Leverage government R&D spending.*
> >
> > *Introduce market relevance into R&D decision making.*
> >
> > *Accelerate the R&D process and transfer of results into the economy and the marketplace.*
>
> *With private-sector budgets cut and refocused toward near-term results, cost-sharing enables companies to explore R&D options that otherwise would be screened out, and to do so with a longer time horizon. At the same time, it permits federal dollars to be stretched. Thus the aligning of public and private support permits the leveraging of increasingly scarce R&D dollars. ... Cost-sharing can be phased, so that industry shoulders an increasing share of the financial burden as the project progresses.*

B.8 1999 PCAST Energy Study

In June 1999, PCAST issued its second report on Energy R&D. This report was prepared by the Panel on International Cooperation on Energy Research, Development, Demonstration, and Deployment, and was titled "Powerful Partnerships: The Federal Role in International Cooperation on Energy Innovation."

The Panel recommended initiatives in four categories—foundations of energy innovation and cooperation, energy end-use efficiency, energy-supply technologies, and management of the government's activities in support of energy research, development, demonstration, and deployment (ERD^3). The third initiative, international cooperation on energy supply technologies, consisted of three initiative clusters, focused on widespread use of renewable energy, fossil-fuel decarbonization and CO_2 sequestration, and nuclear fission and fusion.

The nuclear energy cluster contained three high priority elements: an explicit international component of the NERI program, expansion and strengthening of international cooperative

efforts in studies and information exchange on geologic disposal of spent tuel and high level wastes, and a new international agreement on fusion R&D.

PCAST recommended funding to these three clusters of international initiatives as follows:

- Widespread Renewables: $40M in FY01, ramping to $80M in FY05
- Fossil Fuel: : $20M in FY01, ramping to $40M in FY05
- Nuclear Energy: : $10M in FY01, ramping to $20M in FY05

B.9 Strategic Direction for the 21st Century

Each year since 1998, the Nuclear Energy Institute has issued a strategic report on nuclear energy. The May 2000 report, entitled "Nuclear Energy: The Renaissance Revealed: A Strategic Direction for the 21st Century" built on the prior two reports in addressing its eight compass points for setting the direction for nuclear energy in the 21st century. Those compass points are:

1. Ensuring a national energy policy that provides a diverse and reliable energy supply
2. Maintaining excellence in safe and reliable nuclear power plant operations worldwide
3. Achieving a safety-focused and performance-based regulatory framework
4. Attaining an integrated used fuel disposal program and a flexible low-level waste management approach
5. Capitalizing on nuclear energy's intrinsic environmental value
6. Maximizing the value of nuclear generating assets in a competitive electricity market
7. Increasing the strong public and policymaker support for nuclear energy
8. Building the next generation of nuclear power plants and technology

This Strategic Direction serves as an overall strategic guide for the industry, and has helped shape and prioritize R&D at EPRI. Compass Point One contains specific support for NEPO.